at approximately $6.14 million. Maybe more significant would be the increased incompatible uses in the shifted RPZ. An estimated 12 commercial units would be in the shifted RPZ which is higher than any other alternative and eight more than current. An estimated 15 residential units would lie under the shifted RPZ which is also higher than any other option and significant as the current Runway 13 RPZ does not contain any residential units.

RSA Declared Distance Option Summary

Prior FAA approval for implementation of declared distances is always required. A primary goal of the declared distance options was to provide maximum safety standards and will also provide a runway length capable of serving existing and future business jet operators.

Through the existing declared distances, design standards for the RSA and OFA can be met. The analysis, however, did not adjust the declared distances so as to also meet RPZ requirements as was done earlier in the chapter. The current RPZ for both ends of the runway extends beyond airport property and covers incompatible uses. The Runway 13 RPZ covers five commercial properties, while the Runway 31 RPZ also covers five commercial properties but also 12 residences. This determination would consider the declared distance Options 2a, 2b, and 3 to be prudent and/or feasible as long as the FAA allows for OFA and RPZ modification to standards accordingly. As such, these alternatives can be considered further until and/or unless the FAA deems them objectionable.

RSA ALTERNATIVE E: ENGINEERED MATERIALS ARRESTING SYSTEM (EMAS)

EMAS is an engineered compressible concrete material that is situated beyond the runway end for the purpose of safely stopping an aircraft overrun. EMAS is not considered as a substitute for aircraft undershoots; thus, 600 feet of RSA is still necessary prior to the landing threshold.

EMAS has a similar function to the sandy, high-speed exits provided on highways in mountainous terrain in order to safely stop a runaway tractor-trailer. The FAA considers the installation of EMAS as an acceptable substitute to providing the full RSA. EMAS is designed to stop an aircraft overrun by exerting predictable deceleration forces on the landing gear as the EMAS material crushes. It is designed to minimize the potential for structural damage to the aircraft, since such damage could result in injuries to passengers and/or affect the predictability of deceleration forces.

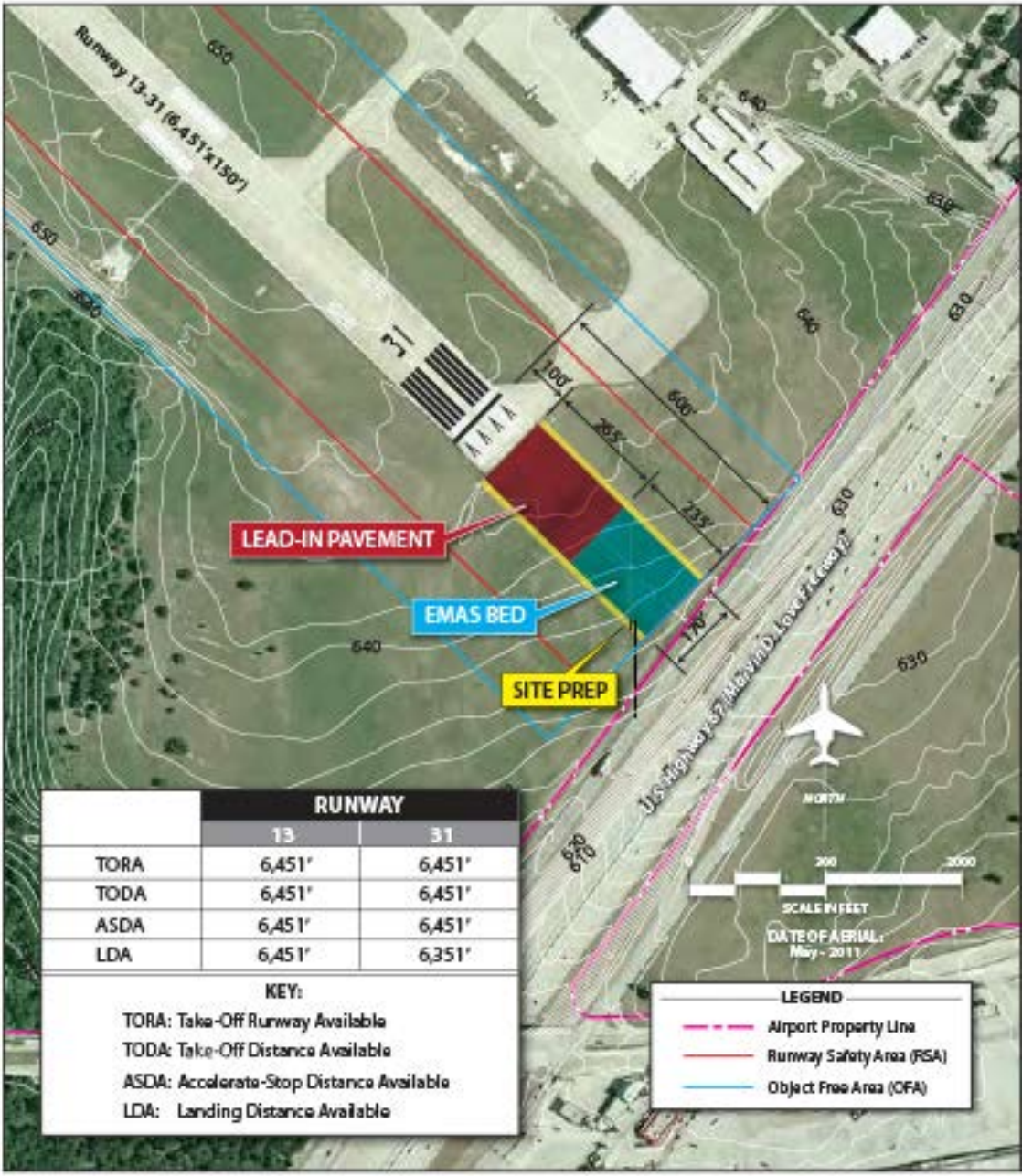
Guidance for evaluating an EMAS alternative and for determining the maximum financially feasible cost for RSA improvements is provided in FAA Order 5200.9, *Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Material Arresting Systems.*

A standard EMAS installation is capable of safely stopping a design aircraft that leaves the runway end traveling at 70 knots or less. The RSA where the EMAS is located should also provide for potential short landings to runway ends with vertical guidance. Vertical guidance to Runway 31 is available via the ILS glideslope antenna and the visual approach slope indicator (VASI) lights. Therefore, a standard EMAS bed would be a portion of the 600-foot RSA needed prior to landing.

The manufacturer and installer of EMAS has provided an analysis of the system required for Dallas Executive Airport given the airport's current critical aircraft. Based on their analysis, the EMAS system which would need to be installed would consist of a 265-foot by 170-foot paved lead-in surface leading into the 235-foot by 170-foot EMAS bed. In order to allow for emergency equipment, an area 500 feet long by 200 feet wide should be prepped and stabilized as depicted on **Exhibit 4M**. The EMAS bed and installation is estimated to cost $4.4 million (2012 cost basis). The lead-in pavement and site preparation is estimated to cost $815,000. A MALS is estimated at $1.0 million. Thus, total EMAS costs are estimated at $6.22 million.

The benefits of providing EMAS would be that it would serve as the full 1,000-foot RSA for Runway 13 operations. As such, all declared distances for Runway 13 under the EMAS option would be the current runway length of 6,451 feet. For Runway 31, all declared distances

Exhibit 4M: EMAS OPTION



	RUNWAY	
	13	31
TORA	6,451'	6,451'
TODA	6,451'	6,451'
ASDA	6,451'	6,451'
LDA	6,451'	6,351'

KEY:
TORA: Take-Off Runway Available
TODA: Take-Off Distance Available
ASDA: Accelerate-Stop Distance Available
LDA: Landing Distance Available

with the exception of the LDA would also be 6,451 feet. The LDA would be reduced by 100 feet; however, as the landing threshold would need to be displaced in order to provide the full 600 feet of RSA prior to landing.

Adding EMAS to the south end of Runway 13-31 is a viable and even prudent option. This option would allow the runway to provide equal length as is provided currently. The negative attribute of this alternative is the cost. Basically, adding EMAS would cost approximately $5.215 million while only preserving existing runway length. Obviously, this option is much better than losing operational runway length as proposed in several previous alternative options. Considering the significant investments, both public and private, already made in the airport, EMAS would support and protect these investments. As such, this alternative is considered viable and prudent and may be explored further in this study.

RSA ALTERNATIVE F: COMBINATION METHOD

The combination method provides for the flexibility to combine runway relocation, shifting, realignment, EMAS, and/or reduction in order to provide the full RSA. Any combination method will have to include declared distances in order to meet RSA standards. The combination method could also be utilized to shift the RPZs to meet design standards (as was depicted earlier on **Exhibit 4C**).

So far in this RSA determination analysis, the only consideration given in each alternative was for the RSA only without mitigation proposed for the RPZ. This approach was taken so as to independently study the RSA apart from the RPZ issues. It is very possible, however, that the FAA will require any RSA solution to include a solution for meeting the RPZ standard. In fact, the mitigating factor in the FAA decision would be the obligation of federal grant funds necessary to improve the RSA. The FAA many times will not require a change in non-standard conditions until such time as a grant request is made. Thus, it is important that this analysis provide some alternative measures to meet both RSA and RPZ standards that are acceptable to the airport and the FAA if required.

Exhibit 4N presents two alternatives which propose combinations of previously outlined alternatives. Both alternatives include a 685-foot northerly extension so as to maximize runway length in both directions. Each alternative also includes a 400-foot displacement of the Runway 13 landing threshold and a 500-foot displacement of the Runway 31 landing threshold. As proposed, the displacements would shift the approach RPZs to both runways and the departure RPZ for Runway 31 away from incompatible land uses. In fact, the approach RPZ for Runway 13 and departure RPZ for Runway 31 would be fully contained on existing airport property as they are essentially the same surface (same size and same location). The approach RPZ for Runway 31 would still extend beyond existing airport property; however, the area outside current property would be over roads and/or areas without any structures. From this point, the alternatives differ in their approach.

RSA Combination Method Alternative 1

Alternative 1 would utilize those improvements outlined above but would then apply declared distances to mitigate RSA deficiencies. For Runway 13, the 685-foot extension would allow for the runway to provide a TODA of 7,136 feet which would equate to the entire length of new pavement. The TORA would be slightly shorter at 6,766 feet which would account for a reduction of 370 feet due to the shifted departure RPZ as depicted. The ASDA for Runway 13 would be 6,643 feet which would be computed by adding 685 feet (proposed extension) to the existing 6,451 feet of runway length, and then subtracting 493 feet which is the RSA deficiency beyond the far end of the runway. The LDA for Runway 13 would be the least of all declared distances at 5,558 feet. The LDA would be calculated by reducing the current runway length, 6,451 feet by 400 feet for the displacement, and another 493 feet for RSA deficiency at the far end of the runway. It should be noted that this alternative would not provide for the full OFA beyond the far end of the runway. If the full OFA is required by the FAA, the ASDA and LDA would need to be reduced by another 32 feet.

For Runway 31, the TORA would be 6,051 feet to account for the departure RPZ which would require the calculation to end at the proposed location of the Runway 13 displaced threshold (6,451 feet minus 400 feet). The TODA would include the entire length of pavement at 7,136 feet. The ASDA would also include the entire length of pavement, or 7,136 feet as the full 1,000 feet of RSA could be provided beyond the proposed extension. The LDA for Runway 31 under this alternative would be 6,636 feet to account for the full length of runway pavement minus the proposed 500-foot displaced threshold (7,136 minus 500 feet). Similar to the Runway 13 declared distances, the Runway 31 declared distances for ASDA and LDA

would not include providing the full OFA. If the full OFA is also required by the FAA, the ASDA and LDA for Runway 31 would need to be reduced by another 150 feet.

The costs associated with this alternative have been estimated at $5.14 million. This alternative would also require the relocation of the glideslope and localizer antennas at an estimated $1.5 million and installation of a MALS at $1.0 million. Thus, the total costs for implementing this alternative are estimated at $7.64 million.

RSA Combination Method Alternative 2

Alternative 2 considers all improvements mentioned before and also includes the implementation of EMAS at the south end of the runway. Adding EMAS to the south end of the runway has no impact on any declared distances for Runway 31 as it is aimed specifically at improving operational length calculations for Runway 13 only. As discussed, Runway 13 is utilized more frequently than Runway 31 as predominant winds are from the south. Moreover, southerly winds generally flow during very hot days. As a result, Runway 13 will generally be in use when turbine aircraft runway length needs are greater as jet aircraft require longer take-off rolls at higher temperatures.

Adding EMAS to the south end of the runway as depicted on **Exhibit 4N** would not change the TORA or TODA from that provided in Combination Method Alternative 1; however, it would increase the ASDA and LDA calculations. EMAS installation as proposed would allow the south end of the runway to provide the full 1,000-foot equivalent RSA. As a result, the Runway 13 ASDA would be the full pavement length, or 7,136 feet. The LDA would be 6,051 feet to account for the proposed 400-foot landing threshold displacement (from current runway end).

The costs for RSA Combination Method Alternative 2 would include all of the $7.64 million associated with Alternative 1. It would also include another estimated $5.215 million for EMAS installation. Thus, total estimated costs for implementing Alternative 2 would be $12.86 million.

RSA Combination Method Summary

The primary benefits of the combined method alternatives would be the ability to provide greater declared distances than could be provided by simply using declared distances to meet RPZ requirements as presented on **Exhibit 4C**. The combination alternatives provide less declared distances than those proposed in RSA Declared Distance Options 2, 2b, and 3 presented earlier; however, the combination method would account for the RPZs allowing for FAA standards to be met. Thus, the combination method would satisfy both RSA and RPZ design standards while maximizing operational lengths.

There are two primary drawbacks associated with the two combination methods. First, the costs would be relatively high to include a 685-foot extension for both alternatives and EMAS in Alternative 2. Second, the extended runway pavement would not have full utility. For example, the runway extension would not be usable for landings on Runway 13. While these drawbacks are considered, they do not outweigh the benefits achieved as the reduced operational lengths required for meeting both RSA and RPZ without these improvements would be significant. Reducing the declared distances (or simply reducing the runway length) to below 6,000 feet would significantly reduce the utility of the runway for business jets. As a result, operations would be lost by both itinerant and based aircraft. In fact, some based aircraft operators (i.e., the Gulfstream II and IV) could elect to base their aircraft elsewhere. Obviously, this could pose significant financial impacts on the airport's FBOs which have invested millions of dollars in facilities aimed at accommodating these aircraft.

The combination method alternatives are the only alternatives presented in this study which meet both RSA and RPZ design standards while also maximizing operational lengths. While the costs are relatively high, the combination method alternatives are feasible and prudent if the FAA requires that the full RSA and RPZ standards be met.

RSA DETERMINATION SUMMARY

Each of the six RSA mitigation alternatives, as prescribed by the FAA, has been analyzed in their application to Dallas Executive Airport and is presented in **Table 4A**. Three of the six alternatives were considered feasible and/or prudent. **Exhibit 4P** presents a comparable table for each of the alternatives considered prudent and/or practicable for quick reference.

The preparer of this study cannot choose a single solution as the final plan will first require that the FAA indicate to what extent RSA, OFA, and/or RPZ standards should be met. Once the FAA provides that direction, the best solution can be

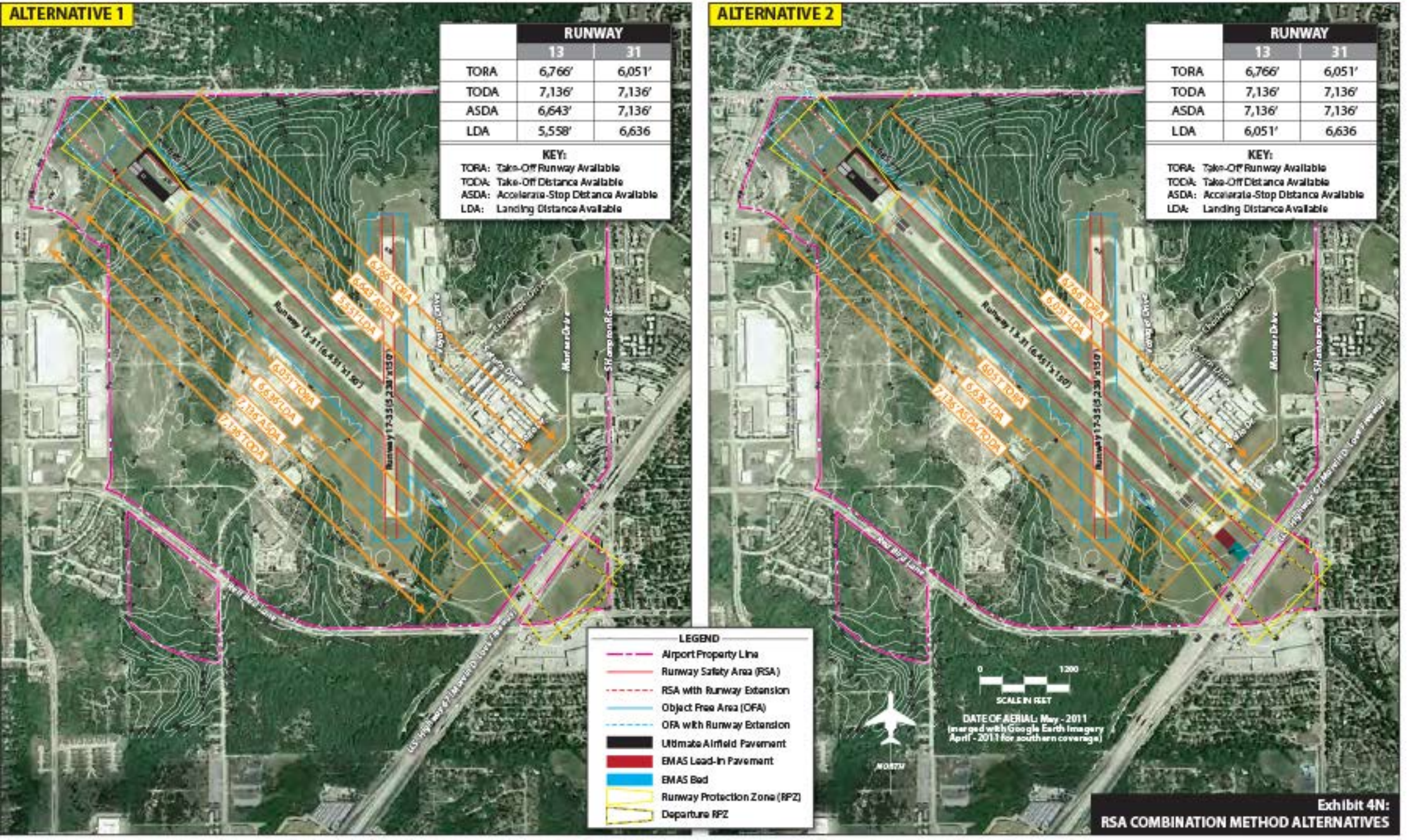


Exhibit 4N:
RSA COMBINATION METHOD ALTERNATIVES

	Alternative D - Option 2a Implement Declared Distances		Alternative D - Option 2b Implement Declared Distances		Alternative D - Option 3 Implement Declared Distances		Alternative E - Engineered Materials Arresting System (EMAS)		Alternative F - Option 1 Combination Method		Alternative F - Option 2 Combination Method	
PHYSICAL FACTORS												
Effective Runway Length	13	31	13	31	13	31	13	31	13	31	13	31
Take-off Run Available (TORA)	6,986'	6,986'	6,986'	6,986'	7,136'	7,136'	6,451'	6,451'	6,766'	6,051'	6,766'	6,051'
Take-off Distance Available (TODA)	6,986'	6,986'	6,986'	6,986'	7,136'	7,136'	6,451'	6,451'	7,136'	7,136'	7,136'	7,136'
Accelerate-Stop Distance Available (ASDA)	6,493'	6,986'	6,461'	6,986'	6,643'	7,136'	6,451'	6,451'	6,643'	7,136'	7,136'	7,136'
Landing Distance Available (LDA)	6,493'	6,889'	6,461'	6,861'	6,643'	7,039'	6,451'	6,351'	5,558'	6,636'	6,051'	6,636'
Property Acquisition	None proposed*		None proposed*		None proposed*		None proposed*		0 acres - Runway 13 RPZ ±2.4 acres - Runway 31 RPZ		0 acres - Runway 13 RPZ ±2.4 acres - Runway 31 RPZ	
Facility Relocation	VASI-4 (13 & 31); REILs (13); Runway thresholds (13 & 31); Localizer; Glideslope antenna		VASI-4 (13 & 31); REILs (13); Runway thresholds (13 & 31); Localizer; Glideslope antenna		VASI-4 (13 & 31)); REILs 13; Runway thresholds (13 & 31); Localizer; Glideslope antenna		VASI-4 (31); Runway threshold (31); Glideslope antenna		VASI-4 (13 & 31); REILs (13); Runway thresholds (13 & 31); Localizer; Glideslope antenna		VASI-4 (13 & 31); REILs (13); Runway thresholds (13 & 31); Localizer; Glideslope antenna	
Infrastructure Development	Northerly 535' runway and parallel taxiway extension; In-pavement MALS on Runway 31 (Remove LDIN)		Northerly 535' runway and parallel taxiway extension; In-pavement MALS on Runway 31 (Remove LDIN)		Northerly 685' runway and parallel taxiway extension; In-pavement MALS on Runway 31 (Remove LDIN)		500' by 200' area prepped and stablized for EMAS; In-pavement MALS on Runway 31 (Remove LDIN)		Northerly 685' runway and parallel taxiway extension; In-pavement MALS on Runway 31 (Remove LDIN)		Northerly 685' runway and parallel taxiway extension; 500' by 200' area prepped and stablized for EMAS; In-pavement MALS on Runway 31 (Remove LDIN)	
OPERATIONAL FACTORS												
Aircraft Operations	Meets RSA design standards		Meets RSA and OFA design standards		Meets RSA design standards		Meets RSA and OFA design standards		Meets RSA and RPZ design standards		Meets RSA and RPZ standards	
Facility Maintenance	Maintain additional 535' of runway and taxiway pavement		Maintain additional 535' of runway and taxiway pavement		Maintain additional 685' of runway and taxiway pavement		Maintain EMAS bed		Maintain additional 685' of runway and taxiway pavement		Maintain additional 685' of runway and taxiway pavement; Maintain EMAS bed	
DEVELOPMENT COSTS	**$5.40 million**		**$5.40 million**		**$6.14 million**		**$6.22 million**		**$7.64 million**		**$12.86 million**	

* RPZ and departure RPZ would continue to extend beyond airport property. Would require approval by FAA.

Exhibit 4P: RUNWAY 13-31 SAFETY AREA ALTERNATIVES SUMMARY

Table 4A: RUNWAY SAFETY AREA ANALYSIS SUMMARY

Option #	RSA Alternative	Prudent and/or Feasible	Comments
A	Provide full RSA	No	RSA beyond Runway 31 end cannot be extended due to the location of U.S. Highway 67 and its outer roads.
B	Relocate, shift, or realign runway	No	Relocation not possible in close proximity due to urbanized area; Runway shift not advisable due to RPZ shift over additional commercial and residential properties; Realigning runway not feasible; Upgrading Runway 17-35 to replace Runway 13-31 would not be feasible as it could not provide more length and would be cost-prohibitive.
C	Reduce runway length	No	Would have significant operational impact on current airport users and FBOs; would negatively impact sizable investments made by sponsor, TxDOT, and FBOs.
D	Declared distances	Yes	Five Options presented with Options 2a, 2b, and 3 considered prudent and/or feasible; however, these options would not mitigate for incompatible land uses in the RPZs.
E	EMAS	Yes	Cost estimated at $6.22 million; would not mitigate incompatible uses in the RPZs.
F	Combination	Yes	Two combination method alternatives presented having relatively high costs; Only alternative which would allow the airport to comply with both RSA and RPZ design standards; Should only be considered prudent and/or feasible if the FAA requires the full RSA and RPZ to meet standards.

Source: Coffman Associates analysis of FAA Order 5200.8 Runway Safety Area Program

selected. If the FAA does not require that the RPZs be mitigated from incompatible uses, for example, one of the RSA Alternative D options and/or Alternative E could be the best choice. If the full RSA and RPZ are required, the combination alternatives presented in RSA Alternative F would be the best solution. This study will be presented to airport staff, Texas Department of Transportation - Aviation Division (TxDOT), FAA, and airport users. It is intended that these meetings will provide proper guidance to make an appropriate choice. The recommended solution will be outlined in the next chapter of this study.

OTHER AIRFIELD ALTERNATIVES

Now that the airfield standards and RSA determination is complete, analysis for issues relating to other airfield developments will be analyzed. Analysis in the previous chapter indicated that Runway 17-35 should be extended to better serve up to small corporate aircraft for periods when the primary runway is closed. Taxiway improvements will also be addressed.

RUNWAY 17-35

Runway 17-35 is currently 3,800 feet long by 150 feet wide. As mentioned earlier, this runway is better suited to predominant winds, especially for small aircraft. It would be ideal for the runway to provide longer runway length to meet the needs of corporate aircraft including small business jets. Moreover, if the runway were extended, it would allow the airport to remain open to serve up to small business jet aircraft when the primary runway is closed. Current plans include a rehabilitation of Runway 13-31. Depending on the type of rehabilitation, Runway 13-31 could need to be closed for anywhere from one month up to nine months. It was determined in the RSA determination section earlier that upgrading Runway 17-35 to ARC C/D-II standards would be cost-prohibitive. Extending the runway so as to provide longer operational length under ARC B-II design, however, can be achieved.

Exhibit 4Q presents two alternatives for extending Runway 17-35. The alternatives consider meeting the full RSA and OFA standards on existing property while also providing the full RPZ for the north end of the runway on property. The southern RPZ can extend into the open area south of the airport as long as the property is acquired in fee or through easements.

Alternative 1, presented on the left side of **Exhibit 4Q**, proposes extensions to both ends of the runway. The runway could be extended 303 feet to the south while maintaining the full ARC B-II RSA which extends 300 feet beyond the runway. The RSA would be placed at the airport perimeter fence just north of the perimeter road. The alternative also considers a 409-foot northerly extension. This extension was selected to minimize costs associated with having to fill and embank areas farther north. The resultant runway length provided by Alternative 1 would be 4,512 feet. Costs associated with this alternative have been estimated at $4.914 million without consideration of property costs for the south RPZ.

Alternative 2 is essentially the same as Alternative 1, however, the proposed northerly extension of Runway 17-35 is 511 feet. This is the maximum extension possible which would allow the RPZ to remain on current airport property. As proposed, this alternative would provide 4,614 feet of runway length. The costs of implementing Alternative 2 have been estimated at $5.95 million.

The two extension alternatives for Runway 17-35 would improve the runway's ability to serve small business jets during most days. On hot days, however, the proposed length could be too short to meet turbine aircraft needs. After meeting with the airport staff, TxDOT, and the PAC, an alternative will be selected and carried forward into the next chapter.

TAXIWAYS

The taxiway system at Dallas Executive Airport includes partial parallel taxiways, entrance/exit taxiways, and connector taxiways. The primary consideration in this analysis is to ensure that the taxiway system meets FAA design standards.

Analysis in the previous chapter indicated that future planning should consider the opportunity for the critical aircraft to transition to ARC C/D-III. Moreover, planning should also factor the implementation of a Category I (CAT I) precision instrument approach procedure with visibility minimums of ½-mile and cloud ceilings as low as 200 feet on Runway 31. In order to meet FAA standards for ARC C/D-III and/or a CAT I instrument approach, the parallel taxiway serving the runway designed for such would need to be separated from the runway by at least 400 feet (centerline to centerline). Partial parallel Taxiway B serving the northwestern portion of Runway 13-31 does not currently meet this standard. Taxiway B is currently located 300 feet east of the runway (centerline to centerline).

Exhibit 4R illustrates the alternative of shifting Taxiway B to a location 400 feet east of the runway centerline. It would also include a new connector stub taxiway linking the east apron with Taxiway B through Runway 17-35. It is believed that the shifted taxiway will also need to serve an extended runway as presented in the Runway Safety Area Determination section earlier. Therefore, Taxiway B would need to be shifted 100 feet to the east and then extended either 535 feet or 685 feet northwest of its current end location as depicted on the exhibit.

Shifting the taxiway 100 feet east, and then extending it 535 feet to the proposed extended runway is estimated to cost $16.654 million. For the proposed 685-foot extension and 100-foot easterly shift, costs are estimated at $16.96 million. The relatively high costs for relocating and extending Taxiway B are, in large part, due to the significant elevation changes north of existing Taxiway B. Thus, if the runway is extended as proposed in either alternative, the costs associated with shifting the taxiway to be 400 feet east of the runway would likely be considered too high. As a result, Runway 13-31 may not be capable of meeting ARC C/D-III runway-to-taxiway separation standards and thereby not qualify for CAT I instrument approach minimums.

LANDSIDE PLANNING ALTERNATIVES

The purpose of this section is to identify and evaluate viable landside alternatives at Dallas Executive Airport to meet program requirements set forth in the previous chapter. While the airfield is comprised of facilities where aircraft movement occurs (runways,